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I, the below undersigned translator, hereby state and declare that:

a) My name and post office address are as stated below.

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c) I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2003.8.28

Date

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1. **Title of the invention**

REFLECTIVE TYPE-FRINGE FIELD SWITCHING MODE LCD

2. **BERIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a separable strabismal view showing a reflective type FFS-LCD, off field according to prior art.

FIG. 2 is a separable strabismal view showing a reflective type FFS-LCD when approving fringe field according to prior art.

FIG. 3 is a separable strabismal view of a reflective type FFS-LCE according to a first embodiment of this invention.

FIG. 4 is a plan view of a lower substrate according to a first embodiment of this invention.

FIG. 5 is a drawing describing operation of a reflective type FFS-LCD off field according a first embodiment of this invention.

FIG. 6 is a drawing describing the operation of a reflective type FFS-LCD when approving a fringe field according to a first embodiment of this invention.

FIG. 7 is a separable strabismal view of a reflective type FFS-LCD according to a second embodiment of this invention.

FIG. 8 is a drawing describing operation of a reflective type FFS-LCD off field according to a second embodiment of this invention.

FIG. 9 is a drawing describing operation of a reflective type FFS-LCD when approving a fringe field according to a second embodiment of this invention.

FIG. 10 is a graph showing a reflectance according to a retardation($d\Delta n$) in a reflective type FFS-LCD value in accordance with this invention.

FIG. 11 is a graph showing a contrast ratio according to a azimuth in a reflective type FFS-LCD of this invention.

- **Description of drawing numbers -**

40 : lower substrate	41a, 41b : gate bus line
42 : common signal line	43, 430 : count electrode
44 : gate insulating layer	45 : channel layer
46, 460 : pixel electrode	47a, 47b : data bus line
48 : drain electrode	49 : source electrode
50 : thin film transistor	53 : first alignment layer
60 : upper substrate	63 : second alignment layer
70 : polarizer board	75 : reflective board

3. Description of the invention

1) FIELD OF THE INVENTION

The present invention relates to a reflective type liquid crystal display, more particularly to a reflective-type fringe field switching mode LCD(hereinafter, reflective FFS-LCD) capable of improving a reflection rate thereof.

2) BACKGROUND OF THE INVENTION

A twisted nematic(TN) mode LCD having nematic liquid crystal compositions of positive dielectric anisotropy of twisted alignment has been used for the conventional reflective type LCD. This reflective type TN-LCD has a low power consumption property and are used for relatively compact LCDs of a electronic clock, a digital clock and so on. However, the reflective TN-LCD has chronic problems of a poor viewing angle and a low contrast ratio.

Consequently, a reflective type - fringe field driving liquid crystal display device is now in the process of research and development to ensure a good viewing angle property, a high reflective rate and an opening rate. The composition of this conventional reflective-type fringe field driving liquid crystal display device is approximately illustrated in FIG. 1 and 2.

Referring to FIG. 1 and 2, a lower substrate(10) is

opposed to a upper substrate(15) at some distance. A liquid crystal layer(17) having a plurality of liquid crystal molecules is interposed between the lower substrate(10) and the upper substrate(15). A counter electrode(11a) and a pixel electrode(11b) forming a fringe field to operate the liquid crystal molecules, are disposed on the inside surface of the lower substrate(10). A color filter(not illustrated) is disposed on the inside surface of the upper substrate(15). A first horizontal alignment layer(12) is interposed between the lower substrate(10) including the counter electrode(11a) and the pixel electrode(11b), and the liquid crystal layer(17). A second horizontal alignment layer(16) is interposed between the upper substrate(15) including the color filter and the liquid crystal layer(17). At this time, the first and the second horizontal alignment layers(12, 16) have rubbing axes(R1, R2) respectively, and the rubbing axis(R1) of the first horizontal alignment layer(12) and the rubbing axis(R2) of the second horizontal alignment layer(16) are, 180°, anti-parallel each other. In addition, the rubbing axis(R1) is at some angles with the line(f) which on the substrate surface, projects the fringe field that is formed between the counter electrode(11a) and the pixel electrode(11b). A polarizer(8) is attached on the outside surface of the upper substrate(5) so that polarization axis(8a) thereof is equal to the rubbing axis(R1) of the first horizontal alignment layer(12). A λ /4 board polarizing an incident light or a reflected light by λ /4 is disposed on the outside surface of the lower substrate(10), and on the out side of the λ /4 board(19), a reflective board(10) reflecting the light which passes through the λ /4 board(19), is disposed. At this time, the λ /4 board(19) is disposed so that its delayed axis is at an angle of 45° with the first rubbing axis(R1).

Such conventional reflective-type FFS-LCD operates as following :

First, referring to FIG. 1, if voltage difference does

not occur between the counter electrode(11a) and the pixel electrode(11b), the liquid crystal molecules(not illustrated) are arranged so that the rubbing axes(R1, R2) and the long axis are parallel. Consequently, a natural light(22a) becomes an incident light(22b) proceeding to an equal direction to a polarization axis(18a) by passing through a polarizer(18). Thereafter, the liquid crystal molecules pass through the liquid crystal layer(17) which the rubbing axes(R1, R2) and the long axis are arranged side by side thereon, and therefore the direction of the incident light(22b) is not changed. The incident light(22b) which has passed through the liquid crystal layer(17), is at an angle of 45° with the delayed axis of the λ /4 board(19), thereby becoming a right circular polarized light(22c) passing through the λ /4 board(19). The right circular polarized light(22c) is reflected by a reflective board(20), thereby becoming a right circular polarized reflected light(23a).

The reflected light(23a) becomes the reflected light(23a) proceeding to a crossing direction with the axis of the polarized light(18a), passing through the λ /4 board(19) having the delayed axis at an angle of 45° with the proceeding direction thereof. The proceeding direction of the reflected light(23b) which has passed through the λ /4 board(19), is orthogonal to the long axis of the liquid crystal layer(17), thereby passing through the liquid crystal layer(17) without being changed. The reflected light(22b) which has passed the liquid crystal layer(17), is orthogonal to the axis of the polarized light(18a), thereby not passing through the polarizer(18). Accordingly, a screen becomes dark.

Next, like FIG. 2, if a fringe field(F) is formed between the counter electrode(11a) and the pixel electrode(11b), the liquid crystal molecules(not illustrated) are twisted into a fringe field form. Consequently, the optical axes of the liquid crystal

molecules(not illustrated) are at some angle with the axis of the polarized light(8a). A natural light(25a) passes through the polarizer(18), thereby becoming an incident light(25b) proceeding to an equal direction to the axis of the polarized light(18a). Thereafter, the incident light(25b) is at an angle of 45° with a long axis of a liquid crystal molecule which is arranged in a fringe field(F) form. Therefore, an incident light(25c) which has passed through the liquid crystal layer(17), becomes the incident light(25c) which is at an angle of 45° with the axis of the polarized light(18a). Here, the incident light(25c) which has passed through, is equal to a delayed axis(19a) of the λ /4 board(19), thereby passing through the λ /4 board(19) without change in the proceeding direction thereof. The incident light(25c) which has passed through the λ /4 board(19), is reflected by the reflective board(20), thereby becoming a reflected light(26a).

The proceeding direction of the reflected light(26a) is equal to the delayed axis of the λ /4 board(19), thereby passing through the λ /4 board(19) without change the proceeding direction thereof. The proceeding direction of the reflected light(26a) which has passed through the λ /4 board(19), is at an angle of 45° with the long axis of the liquid crystal molecule on the liquid crystal layer(17) and therefore the proceeding direction of a reflected light which has passed through the liquid crystal layer(17), is equal to the axis of the polarized light(18a). Therefore, a screen is in a white state.

Conventional reflective type liquid crystal display device has not used a white light as light source and optical component such as the λ /4 board(19) has been added to the out side of a substrate thereof to improve a contrast.

However, manufacturing cost goes up as the optical component such as the λ /4 board is added. Moreover, the λ /4 board absorbs some of an incident light or a reflected

light, thereby deteriorating transmissivity of the LCD, reflectance.

Accordingly, a object of this invention is to provide a reflective type liquid crystal display device having a good contrast ratio and a good reflectance without an additional optical component.

To accomplish the aforementioned object of this invention, according to a first embodiment of this invention, reflective type FFS-LCD having property of which retardation of a liquid crystal layer is $(2n+1)\lambda/4$(here, λ is wave of light and n is positive numbers), comprising a liquid crystal layer comprising a plurality of the liquid crystal molecules ; a first substrate on which a counter electrode and a pixel electrode causing a fringe field to drive liquid crystal molecules are formed ; a second substrate which is disposed on the contralateral side of the liquid crystal layer ; a first horizontal alignment layer which is interposed between the liquid crystal layer and the first substrate and has a rubbing axis in some direction ; a second horizontal alignment layer which is interposed between the liquid crystal layer and the second substrate and has a rubbing axis in some direction ; a polarizer which is disposed on a out side of the first substrate and the second substrate and has some axes of a polarized light ; and, reflective board which is disposed on the out side of the other substrate of the first substrate and the second substrate.

And, according to another embodiment, reflective type FFS-LCD having property of which the rubbing axes of the first alignment layer and the second alignment layer are at an angle of 10 to 85° with a substrate projection line of the fringe field and which retardation of a liquid crystal layer is $(2n+1)\lambda/4$(here, λ is wave of light and n is positive numbers), comprising a liquid crystal layer including a plurality of the liquid crystal molecules : a liquid crystal layer including a plurality of liquid

crystal molecules ; a first substrate on which a counter electrode and a pixel electrode causing a fringe field to drive liquid crystal molecules are formed ; a second substrate which is disposed on a contralateral side of the liquid crystal layer ; a first horizontal alignment layer which is interposed between the liquid crystal layer and the first substrate and has a rubbing axis in some direction ; a second horizontal alignment layer which is interposed between the liquid crystal layer and the second substrate and has a rubbing axis anti-parallel to a rubbing axis of the first horizontal alignment layer ; a polarizer which is disposed on a out side of the first substrate and the second substrate and has some axes of a polarized light ; and, a reflective board which is disposed on the out side of the other substrate of the first substrate and the second substrate.

3) DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A FIRST EMBODIMENT : A REFLECTIVE TYPE FFS-LCD BY NORMALLY WHITE METHOD

FIG. 3 is a separable strabismal view of a reflective type FFS-LCD according to this invention. Referring to FIG. 3, a lower substrate(40) is opposed to a upper substrate(60) at some distance(d11, hereinafter, cell cap). A liquid crystal layer(65) including a plurality of liquid crystal molecules(65a), is interposed between the lower(40) substrate and the upper substrate(60). At this time, a liquid crystal molecule(65a) of the liquid crystal layer(60) is nematic, and anisotropy of dielectric constant may be positive or negative. In this embodiment, for example, material of positive dielectric anisotropy is used. And, retardation of the liquid crystal layer(65), the cell cap(d11) multiplied by refraction index anisotropy of the liquid crystal molecule(65a), equals $(2n+1)\lambda/4$.

A counter electrode(43a) and a pixel electrode(46a) are disposed on the inside surface of the lower substrate(40)

so as to cause a fringe field to drive the liquid crystal molecule(65a). Here, the inside plane structure of the lower substrate on which the counter electrode(43a) and the pixel electrode(46) is formed, is presented in FIG. 4. Referring to FIG. 4, a plurality of gate bus lines(41a, 41b) are extended and arranged to a x direction of a drawing, keeping certain distance on the lower substrate(40). And, a plurality of data bus lines(47a, 47b) are also extended to a y direction of a drawing, keeping certain distance on the lower substrate(40), thereby limiting unit pixel with the gate bus lines(41a, 41b). In a drawing, only a pair of gate bus lines(41a, 41b) and a pair of data bus lines(47a, 47b) are illustrated. A gate insulating layer(44) is sandwiched between the gate bus lines(41a, 41b) and the data bus lines(47a, 47b), thereby insulating those each other. A common signal line(42) is extended to some direction, for example, to a x direction, and located between a pair of the gate bus lines(41a, 41b). For example, it is desirable that the common signal line(42) is disposed in a location closer to the previous gate bus line(41b) than such gate bus line(41a). Here, to shorten RC delay time, the gate bus liens(41a, 41b), the common signal line(42) and the data bus lines(47a, 47b) are formed out of a metal layer or more than two alloy layers among groups which are composed of Al, Mo, Ti, W, Ta, Cr having relatively good conductive property and combinations thereof.

Counter electrodes(43) are respectively formed on unit pixels of the lower electrode(43). Here, the counter electrodes(43) are formed on the surface of the lower substrate(40) and formed so as to be contacted with the common line(42). The counter electrodes(43) are contacted with the common signal line(42) and therefore approved of the common signal. At this time, the counter electrodes(43) include a plurality of branches(43a) which is extended parallel with the data bus line, and a body part(43b)

connecting groups of the branches(43a). At this moment, the body part(43b) is in part contacted with the common signal line(42). Here, each of the branches(43a) is arranged keeping certain width(P11) or certain distance(L11). The width(P11) and the distance(L11) of each branch(43b) are formed by considering the width of a pixel electrode and the distance with a pixel electrode which will be formed later.

pixel electrodes(46) are also formed in a space of unit pixel of the lower substrate(40) respectively. At this time, the pixel electrodes(46) are formed on the upper of a gate insulation layer(44) so as to be overlapped with the counter electrodes(43). The pixel electrodes(46) includes strips(46a) which are respectively disposed between the branches(43a) of the counter electrode(43) and a bar(46b) which is overlapped with the body part(43b) of the counter electrode(43) connecting groups of the strips(46a). At this time, strips(46a) are arranged keeping certain width(P12) and certain distance(L12) one another. And, the widths(P12) of the strips(46a) may be equal to or narrower than interval(L11) of the branches(43a). Second parts(46b) are located between the branches(43b) of the counter electrode. Here, the strip(46a) of the pixel electrode(46) and the branch(43a) of the counter electrode(43) are separated by some distance. To cause a fringe field, it is desirable that interval between the second part(46b) of the pixel electrode(46) and the branch(43b) of the counter electrode(43) is narrower than that of the cell cap(d11), and for example, when the size of unit pixel is 110μm×330μm, is formed to above 0.1μm to below 5μm. And, the widths(P11,P12) between the branch part(43a) of the counter electrode(43) and the strip(46a) of the pixel electrode(46), by a fringe field which is formed between those, are to a certain that the liquid crystal molecules on the upper of the electrodes(43a, 43b) can be all operated. In addition, the ratio of the width(P12) of the strip(46a) of the pixel

electrode(46) to the width(P11) of the branch(43a) of the counter electrode(43) is 0.2 to 4 or so. Here, according to the size of unit pixel, and the number of the branch(43b) of the counter electrode(43) and the second part(46b) of the pixel electrode(46), the width and the distance between the branch(43b) of the counter electrode(43) and the second part(46b) of the pixel electrode(46) may be movable. However, the width of the electrodes(43a, 43b)is to a certain that the liquid crystal molecules on the upper of the electrodes(43a, 43b) can be all operated by the fringe field between the electrodes(43a, 43b).

Thin film transistors(50), switching devices, are respectively formed near a crossing point in the gate bus lines(41a, 41b) and the data bus lines(47a, 47b). The thin film transistor(50) switches the signal of the data bus line(47a) to the pixel electrode(46) when selecting the gate bus line(41a).

A storage capacitor(Cst) occurs in the part which the counter electrode(43) and the pixel electrode(46) are overlapped, the part which the body part(43b) of the counter electrode(43) and the bar(46b) of the pixel electrode(46) are overlapped. This storage capacitor(Cst) plays a role in maintaining data signal during a frame.

Meanwhile, a color filter(not illustrated) is arranged on the inside surface of the upper substrate(60).

And, a firs alignment layer(53) is formed on the surface of the inside consequence material of the lower substrate(40), and a second alignment layer(63) is formed on the surface of the inside consequence material of the color filter on the upper substrate(60). The first and the second alignment layers(53,63) have the surfaces on which liquid crystal molecule(65a) is arranged to certain direction. The first and the second alignment layers(53, 63) are the horizontal alignment layers which are treated so that the liquid crystal molecule has a pretilt angle of 0 to 10°, and have the rubbing axes(R1, R2) respectively.

Here, the rubbing axis(R1) of the first alignment layer(53) is at some angle(Ψ) with the direction of an x axis(hereinafter, projection line of a fringe field). At this time, the angle which the rubbing axis(R1) of the first alignment layer(53) and the direction of the x axis(hereinafter, projection line of a fringe field) meet, is adjusted in the range of 10 to 85° according to the dielectric anisotropy so as to obtain the maximum transmissivity. The rubbing axis(R2) of the second alignment layer(63) is anti-parallel to the rubbing axis(R1) of the first alignment layer(53), that is, rubbed so as to have the angle difference of about 180°.

And, a polarizer(70) is disposed on the outside surface of the upper substrate(60), and a axis of the polarized light(70a) is disposed parallel to the rubbing axes(R1, R2). A reflective board(75) is disposed on the out side of the lower substrate(40). At this time, the reflective board(75), as announced, plays a role in reflecting an incident light to 180°.

And, an optical component such as a tetrahedral wave board which has been added to conventional reflective type FFS-LCD, is added to the reflective type FFS-LCD of this invention. Instead, the liquid crystal layer serves as $\lambda/4$ board by adjusting retardation of the liquid crystal layer(65).

The reflective type FFS-LCD of this invention having this composition operates as following.

First, if the gate bus line(41a) is not selected, the signal of the data bus line(47a) is not conveyed to the pixel electrode(46b) and therefore a fringe field between the counter electrode(43) and the pixel electrode(46b) is not formed. Consequently, a long axis is parallel to the rubbing axes(R1, R2) so that the liquid crystal molecules(65a) within the liquid crystal layer(65) are arranged almost parallel to a substrate. Then, a natural light(100a), as illustrated in FIG. 5, becomes an incident

light(100b) proceeding to an equal direction to the axis of the polarized light(70a) by a polarization board(70). The incident light(100b) passes through the liquid crystal layer(65) which is arranged so that the rubbing axes(R1, R2) and the long axis of the liquid crystal molecule are equal, and the proceeding direction thereof is not changed. The incident light(100b) which has passed through the liquid crystal layer(65), is reflected by a reflective board(75), thereby becoming a reflected light(110a).

The reflected light(110a) passes through the liquid crystal layer(65) again and the proceeding direction thereof is not changed. Consequently, the proceeding direction of the reflected light(110a) is equal to the polarized light axis(70a) of the polarizer(70), thereby passing through the polarizer(70). Accordingly, a screen is in a white state.

Meanwhile, if the gate bus line(41a) is approved of an injection signal and the data bus line(47a) is approved of a display signal, a thin film transistor(50) which is formed near a crossing point of the gate bus line(41a) and the data bus line(47a), is turned on and therefore conveyed to the pixel electrode(46). At this time, the counter electrode(43) is continuously approved of common signal having a display signal and some voltage difference, and therefore a fringe field(F) is formed between the counter electrode(43) and the pixel electrode(46) and on the upper of the electrode. At this time, the lower substrate projection line of the fringe field(F) is at some angle with the axis of the polarized light(70a). Consequently, the liquid crystal molecule(65a) is arranged so that the fringe field and the long axis or the optical axis are parallel, and therefore retardation occurs in the liquid crystal layer(65) by $(2n+1)\lambda/4$(here, n is a positive number).

Then, a natural light(200a), as illustrated in FIG. 6, becomes an incident light(200b) equal to the axis of the

polarized light(70a) by passing through the polarizer(70). The incident light(200b) which has passed through the polarizer(70) passes through the liquid crystal layer(65) having retardation of (2n+1)λ/4, and therefore the proceeding direction thereof is changed, thereby, becoming a right circular polarized incident light(200c). The right circular polarized incident light(200c) is reflected by the reflective board, thereby becoming a reflected light(210a) being circular polarized right.

The reflected light(210a) becomes a reflected light(210b) orthogonal to the axis of the polarized light(70a) by retardation of the liquid crystal layer(65) again. Consequently, a screen is in a dark state. Consequently, a display can be realized by normally white method without a λ/4 board.

4) EMBODIMENT 2: REFLECTIVE TYPE FFS-LCD BY NORMALLY BLACK METHOD

FIG. 7 is a separable strabismal view of a reflective type FFS-LCD according to a second embodiment of this invention. In this embodiment, a structure of the lower substrate(40), a structure of the upper substrate(60), the liquid crystal layer(65) and the reflective board(75) are equal to those in the first embodiment and only disposition of the polarizer(70) is different. A polarized light axis(70b) of the polarizer(70) is at some angle, preferably 45°, with the rubbing axes(R1, R2) so that a reflective FFS-LCD according to this embodiment, as illustrated in FIG. 7, is operated by normally black method.

Operation of this reflective FFS-LCD by normally black method is described.

First, before a fringe field is formed, the long axis is equal to the rubbing axes(R1, R2) and therefore the liquid crystal molecules(65a) are arranged on a substrate almost parallel. Then, a natural light(300a), as illustrated in FIG. 8, by the polarized light board(70),

becomes an incident light(300b) proceeding to an equal direction to the axis of the polarized light(70a). The incident light(300b) is at an angle of 45° with the long axis of the liquid crystal molecule, thereby becoming an incident light(300c) proceeding to an equal direction to the rubbing axes, passing through the liquid crystal layer(65). The incident light(300c) which has passed through the liquid crystal layer(65) is reflected by the reflective board(75), thereby becoming a reflected light(310a).

The proceeding direction of the reflected light(310a) is at an angle of 45° with the long axis of the liquid crystal molecule(65a), thereby becoming a reflected light(310b) perpendicular to a axis of the polarized light(70b), passing through the liquid crystal layer(65). The proceeding direction of the reflected light(310b) which has passed through the liquid crystal layer(65) is perpendicular to the axis of the polarized light(70b), thereby not passing through the polarizer(70). Accordingly, a screen is in a dark state.

Meanwhile, if a fringe field(F) is formed, the liquid crystal molecule(65a) is arranged so that the fringe field(F) and the long axis or the short axis are parallel, and therefore retardation occurs in the liquid crystal layer(65) by $(2n+1)\lambda/4$(here, n is a positive number). A natural light(400a), as illustrated in FIG. 9, becomes an incident light(400b) equal to the axis of the polarized light(70b) by passing through the polarizer(70). The incident light(200b) which has passed through the polarizer(70) is equal to the long axis of the liquid crystal molecule(65a) which is twisted by the fringe field(F), thereby passing through the liquid crystal layer(65) without change in a polarization state. An incident light(400c) which has passed through the liquid crystal layer(65) is reflected by the reflective board(75), thereby becoming a reflected light(410a).

The reflected light(410a) is equal to the optical axis of the liquid crystal molecule(65) which is arranged in a fringe field form, thereby passing through the liquid crystal layer(65) without change in a polarization state. The proceeding direction of the reflected light(410a) which has passed through the liquid crystal layer(65) is equal to the axis of the polarized light(70b), thereby passing through the polarizer(70). Accordingly, a screen is in a white state. Consequently, a display can be realized by normally black method without $\lambda/4$ board.

FIG. 10 of accompanying drawings is a graph showing reflectance in accordance with retardation($d\Delta$ n) in a reflective type FFS-LCD according to this invention. According to FIG. 8, when λ is 550nm, the points which reflectance are 0 and 0.9 show by regular periods. At this time, at the point of 0 retardation is $(2n+1)\lambda/4$ and at the point of 0.9 retardation is $2n/\lambda$. Consequently, when retardation of the liquid crystal layer(65) is $(2n+1)\lambda/4$, a display can be realized without the $\lambda/4$ board.

FIG. 11 is a graph showing contrast ratio according to azimuth in a reflective type FFS-LCD of this invention. According to FIG. 11, when extreme angle(θ) is more than 30°, contrast ratio is more than 10, and therefore good contrast ratio can be obtained without the $\lambda/4$ board.

This invention is limited to the embodiments described above.

For example, according to the embodiments of this invention, the pixel electrode and the counter electrode are formed in COM forms. However, being not limited to this, the pixel electrode and the counter electrode can be formed in any form so as to form a fringe field.

A reflective type FFS-LCD of this invention has effects as following.

First, in reflective type FFS-LCD, retardation($d\Delta$ n)

uses material having retardation of $(2n+1)\lambda/4$ as the liquid crystal layer. Consequently, the liquid crystal layer serves as conventional $\lambda/4$ board, thereby not requiring to form a separate $\lambda/4$ board. Accordingly, intensity of light increases and price decreases.

Moreover, the liquid crystal molecules between the counter electrode and the pixel electrode and on the upper of the electrodes, are all operated by the fringe field, and therefore reflectance of a reflective type FFS-LCD is further improved.

Within the range of not violating the principle and the spirit of this invention, several embodiments are not only obvious to such company who belongs to this art but invented easily. Accordingly, the range of accompanying claim herein is not limited to what is described previously, and the above range of claim comprises everything new which is immanent in this invention, thereby having patent property, and in addition, comprises all properties which is treated uniformly by the person who have common knowledge in the art field which this invention belongs to.

4. WHAT IS CLAIMED IS:

1. reflective type FFS-LCD having property of which retardation of a liquid crystal layer is $(2n+1)\lambda/4$ (here, λ is wave of light and n is a positive number), comprising a liquid crystal layer including a plurality of the liquid crystal molecules ;

a first substrate which is disposed on the unilateral side of the liquid crystal layer and on which a counter electrode and a pixel electrode causing a fringe field to drive the liquid crystal molecules are formed ;

a second substrate which is disposed on the contralateral side of the liquid crystal layer ;

a first horizontal alignment layer which is interposed between the liquid crystal layer and the first substrate and has a rubbing axis in some direction ;

a second horizontal alignment layer which is interposed between the liquid crystal layer and the second substrate and has a rubbing axis in some direction ;

a polarizer which is disposed on an out side of the first substrate and the second substrate, and has some polarized light axes ; and,

a reflective board which is disposed on an out side of the other substrate of the first substrate and the second substrate.

2. reflective type FFS-LCD according to claim 1, having property of : a rubbing axis of the first horizontal alignment layer and a rubbing axis of the second horizontal alignment layer are anti-parallel or equal each other.

3. reflective type FFS-LCD according to claim 2, having property of : the rubbing axes of the first and the second alignment layers are at an angle of 10 to 85° with a substrate projection line of the fringe field.

4. reflective type FFS-LCD according to claim 1, having property of : the rubbing axes of the first and the second alignment layers and the polarization axis of the polarizer are at and angle of 20 to 60°.

5. reflective type FFS-LCD according to claim 5, having property of : the rubbing axes of the first and the second alignment layers and the polarization axis of the polarizer are at an angle of 45°.

6. reflective type FFS-LCD according to claim 1, having property of : the rubbing axes of the first and the second alignment layers and the polarization axis of the polarizer are parallel.

ABSTRACT OF DISCLOSURE

This invention initiates a reflective type FFS-LCD. A reflective type FFS-LCD of this initiated invention has property of which retardation of the liquid crystal layer is $(2n+1)\lambda/4$ (here, λ is wave of light and n is a positive number), comprising a liquid crystal layer including a plurality of the liquid crystal molecules thereon; a first substrate which is disposed on the unilateral side of the liquid crystal layer and on which a counter electrode and a pixel electrode causing a fringe field to drive the liquid crystal molecules are formed ; a second substrate which is disposed on the contralateral side of the liquid crystal layer ; a first horizontal alignment layer which is interposed between the liquid crystal layer and the first substrate and has a rubbing axis in some direction ; a second horizontal alignment layer which is interposed between the liquid crystal layer and the second substrate and has a rubbing axis in some direction ; a polarizer which is disposed on an out side of the first substrate and the second substrate, and has some polarized light axes ; and, a reflective board which is disposed on an out side of the other substrate of the first substrate and the second substrate.

Selected FIG. : FIG. 3